Modernizing the Prewar HRO

BY LOREN G. WINDOM,* W8GZ

SOME months ago the writer had occasion to compare his prewar HRO receiver (No. Y-219) with several of the new HRO-7 receivers. My conclusion was that the old HRO was still a top-notch receiver but that several improvements were indicated — conversion of the high-frequency oscillator and the addition of a noise limiter. After extended use at W8GZ the writer believes that the following suggested conversion represents a worthwhile improvement in any HRO. What the writer has done is to apply to the HRO the improved circuit of the HRO-7, with certain minor modifications dictated by simplicity.

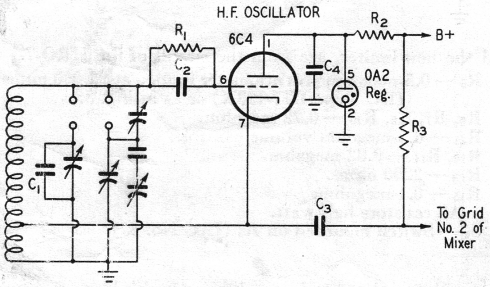


Fig. 1 — Revisions in the high-frequency oscillator circuit.

C_1 — 10-$\mu\mu$fd. ceramic, -0.00077 $\mu\mu$fd./$\mu\mu$fd./°C (see text).
C_2 — 100-$\mu\mu$fd. ceramic.
C_3 — 0.01-μfd. mica, 600 volts.
C_4 — 0.1-μfd. 400-volt paper.
R_1 — 22,000 ohms, ½ watt.
R_2 — 5000 ohms, 10 watts.
R_3 — 0.1 megohm, ½ watt.

* Pickerington Road, Reynoldsburg, Ohio.

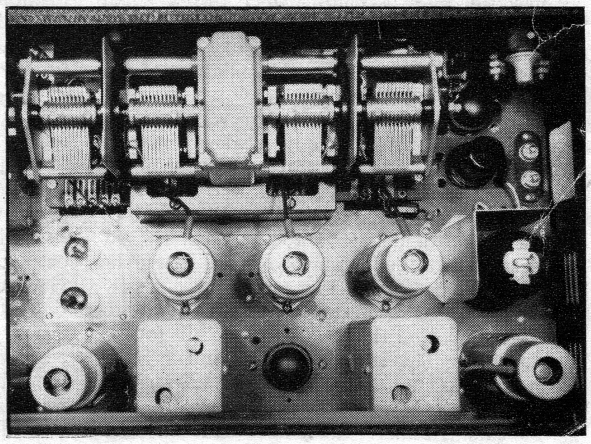
Conversion of the H.F. Oscillator

Conversion of the high-frequency oscillator consists of substituting a 6C4 and associated 0A2 regulator tube in place of the 6C6 or equivalent oscillator and the adding of a temperature-compensating condenser across the oscillator bandspread trimmer condenser. Circuit details are given in Fig. 1.

Remove the present h.f. oscillator tube and socket from the chassis. With a hack-saw blade or similar tool enlarge the present tube-socket hole into a rectangular hole approximately 1¼ by 2 inches. Cut a piece of sheet aluminum into a rectangle approximately 2⅜ inches by 2⅝ inches. On this piece of aluminum mount the sockets for the 6C4 and 0A2 tubes. Space these sockets approximately 1¼ inches between centers. This socket assembly is now centered over the rectangular hole in the chassis and fastened in place by means of small bolts or rivets in each corner of the aluminum sheet. The 6C4 tube must be toward the front. Connect the 6C4 and 0A2 as shown in Fig. 1.

Temperature Compensation

Temperature compensation is obtained by connecting a 10-$\mu\mu$fd. ceramic condenser, with a coefficient of -0.00077 $\mu\mu$fd./$\mu\mu$fd./°C, across the oscillator bandspread trimmer condenser. This temperature compensation is used on the 28-, 14- and 7-Mc. coils. It cannot be used on the 3.5-Mc. coils without modifying the coil-assembly components, which is hardly worth while.



A top view of the "modernized" HRO. The old oscillator tube and socket have been replaced by an aluminum plate that mounts a 6C4 oscillator tube and 0A2 regulator tube. A 6H6 second detector has been substituted, and a 6H6 noise limiter and 6SJ7 audio amplifier have been added.

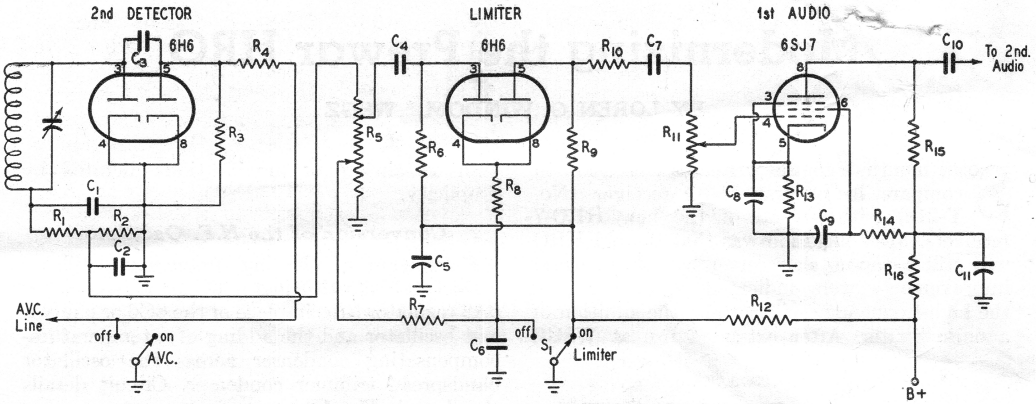


Fig. 2 — The revised second detector and first audio, and the new limiter, are from the circuit of the HRO-7.

C_1 — 270-$\mu\mu$fd. mica or ceramic.
C_2, C_3 — 100-$\mu\mu$fd. mica or ceramic.
C_4, C_5, C_6, C_9, C_{10}, C_{11} — 0.1-μfd. 400-volt paper.
C_7 — 0.01-μfd. 600-volt paper.
C_8 — 25-μfd. 50-volt electrolytic.
R_1, R_{16} — 47,000 ohms.
R_2, R_9 — 0.47 megohm.
R_3, R_4 — 1.5 megohms.
R_5 — 0.5-megohm potentiometer tapped at 22,000 ohms (IRC Type D17-133X) or as in Fig. 3.
R_6, R_7, R_8, R_{10} — 0.22 megohm.
R_{11} — 0.5-megohm volume control.
R_{12}, R_{14} — 0.82 megohm.
R_{13} — 2200 ohms.
R_{15} — 0.1 megohm.
All resistors half-watt.
S_1 — Switch mounted on R_5 (IRC No. 43).

Remove the h.f. oscillator brush board (the bar with four contact fingers in the right-hand coil slot) and add a fifth contact arm to this brush board, by using a piece of spring brass or any other similar material. The brush board is already drilled and slotted for the fifth contact. All that is necessary is to fashion the arm out of suitable metal and fasten it on the board with a small bolt or rivet. If you desire, a new 5-contact brush board can be purchased very cheaply directly from the National Company, Malden, Mass.

Connect the temperature-compensating condenser from this new contact arm to ground. Be sure to leave the condenser leads long enough so that the compensating condenser can be pressed against the 6C4 oscillator tube. Use a small ceramic stand-off insulator to support this condenser and give it mechanical rigidity.

Next remove the 28-Mc. h.f. oscillator coil can from the plug-in rack and remove the coil assembly from its shield can. Solder a connection from Contact 1 (it is plainly marked and was previously unused) to the stator connection of the bandspread trimmer condenser. Make it short and stiff for mechanical rigidity. Replace into the shield can and back onto the rack. Repeat the operation for the 14- and 7-Mc. coils. Leave the 3.5-Mc. coils untouched.

Warm up the receiver and realign the bandspread trimmer on the h.f. oscillator coils for 28, 14 and 7 Mc. This is Adjustment 7 in the HRO instruction manual. A slight decrease in capacity is necessary, because you have added 10 $\mu\mu$fd. across this trimmer. Remember that the h.f. oscillator should always be on the high-frequency side of the signal, so if your oscillator tunes at two points the counterclockwise one is the correct point. See page 8, HRO instruction manual. Check your bandspread. On the 28-Mc. coil, 28.0 Mc. should come at 50 on the dial and 29.7 Mc. should come at 450 on the dial. Similarly, the band limits for the 14- and 7-Mc. coils should come at 50 and 450. If the bandspread is out, realign as outlined on pages 8 and 9 of the manual.

Exact temperature compensation is secured by pressing the compensating condenser closer to or farther away from the 6C4 oscillator tube. In the writer's receiver the correct point is approximately ⅛ inch from the center of the side of the 6C4 tube. At W8GZ this adjustment gives a maximum drift at 29.7 Mc. of plus or minus one (1) dial division, starting with a cold receiver.

If the oscillator "sqegs," or operates at several frequencies simultaneously, reduce the grid leak to around 18,000 ohms or else use a grid condenser of lower capacity. Do *not* change the oscillator coil!

A final point on temperature compensation. Remember that a cold coil plugged into a hot receiver will have some drift in spite of your compensation. You can correct this by keeping the extra coils on top of the receiver or any other place where their temperature will be substantially the same as that of the receiver. If you desire, you can introduce additional temperature compensation directly into the plug-in coils by removing the coils from their shield cans and soldering a small negative-coefficient condenser from Terminal 1 to Terminal 4 on the 28-, 14-

and 7-Mc. coils. The exact size of this condenser will depend upon your own particular HRO. After adding the condenser you must still be able to "zero" the oscillator with the bandspread trimmer condenser. The writer's experience has been that condensers of from 3 to 5 $\mu\mu$fd., with a coefficient of $-0.00077/\mu\mu$fd./$\mu\mu$fd./°C, are about the maximum usable capacities. A little trial and error will give you the best possible combination. However, unless you do a lot of coil shifting this coil compensation is hardly necessary.

Noise Limiter

At W8GZ one of the rhombic antennas parallels a state highway for nearly 1000 feet. The ignition interference is terrific! After much cut and try, the writer settled upon the circuit shown in Fig. 2 as giving the best results with a minimum of change in the HRO.

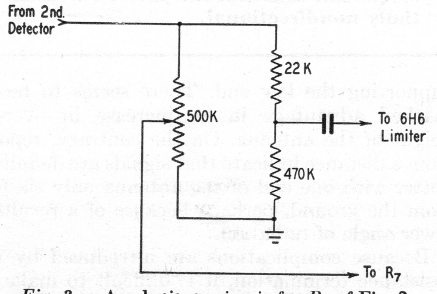


Fig. 3 — A substitute circuit for R_5 of Fig. 2.

The first step is to take your HRO "as is" (either with or without the h.f. oscillator conversion). Connect a signal generator or some source of definitely fixed and unvarying signal to the antenna terminals and feed a 28- or 14-Mc. signal into the receiver. The exact frequency is unimportant. Tune in this signal very carefully and make a note of the S-meter reading. You are now ready to begin work.

Remove the 6B7 second detector and its socket from the chassis and replace with a 6H6 socket and tube. Connect it as shown in Fig. 2. Mount the 6H6 noise limiter and 6SJ7 first audio into the chassis directly behind the S-meter, the 6H6 noise limiter to the front. The noise-limiter control is mounted to the lower right of the headphone jack. Connect as in Fig. 2. Both 6H6 tubes use 4.3-ohm 2-watt resistors in series with the heaters to reduce the voltage at the sockets to 5.0 volts.

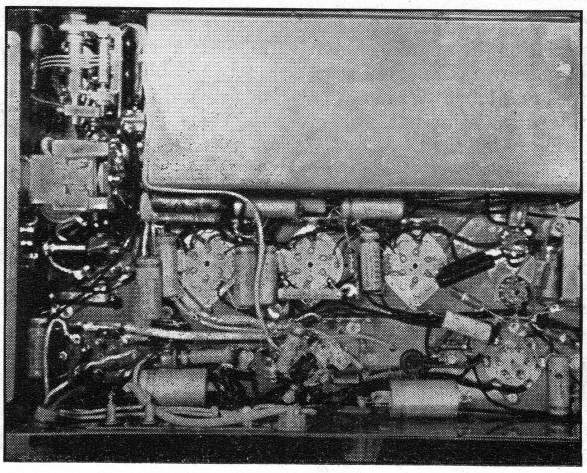
The noise-limiter control may be either a 0.5-megohm potentiometer with a tap at 20,000 to 25,000 ohms (Fig. 2) as is used at W8GZ, or it may consist of a 0.5-megohm potentiometer shunting a 22,000-ohm and a 0.47-megohm resistor (Fig. 3) as in the HRO-7.

After completing the wiring realign the 6H6 second detector for maximum output. (Adjustment 13 and 14, HRO instruction manual.)

Reconnect the signal generator or signal source and again tune the signal in carefully as before. The S-meter reading will now be somewhat lower than it was before adding the noise limiter. Using a long screwdriver or similar tool *very carefully* increase the capacity of the crystal-filter output coupling condenser by turning clockwise (Adjustment 9, HRO instruction manual) until the S-meter reads the same as before installing the limiter. Do *not* go beyond this point or you will lose selectivity.

Your conversion is now complete. The S-meter should operate exactly as it did before conversion. You have a receiver with an extremely stable oscillator and an excellent noise limiter — and last but not least the over-all gain of your receiver is slightly higher than it was before you started work. While you are at it hadn't you better check your tubes and then touch up the alignment of the entire receiver in accordance with the instruction manual?

(*Continued on page 116*)



The added antenna-shorting relay is mounted under the antenna terminals (near the b.f.o. tuning condenser).

An Experimental All-Band Nondirectional Transmitting Antenna

Some Possibilities Offered by the Tilted Folded Dipole

BY G. L. COUNTRYMAN,* W1RBK, W3HH

• Those hams who are experimentally inclined will no doubt be interested in the possibilities that this antenna system suggests. Practical tests by the author have shown that the single antenna may be operated over a frequency range as great as 5 to 1 with a relatively small change in the standing-wave ratio on the line and that the pattern is essentially nondirectional.

FEW improvements in antennas for the lower-frequency bands have been forthcoming for several years. The arrangement to be discussed is not entirely original with the author but was based on some Navy antenna studies. Initial tests indicate that it may provide an acceptable solution to amateur multiband operation.

Briefly, it is an aperiodic system that will give uniform output over a frequency of approximately a 5-to-1 ratio with nondirectional characteristics and without critical adjustment. In fact, the only adjustment is to couple the final tank to a 600-ohm line.

The practical experiments conducted by the author are incomplete, but it is hoped that the publication of the data contained herein will encourage experimenting by other amateurs.

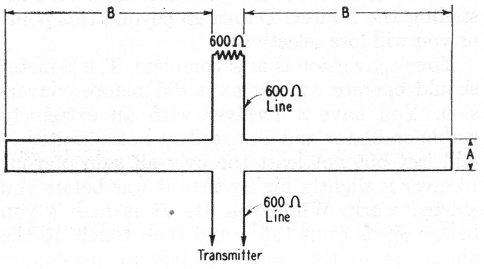


Fig. 1 — General diagram of the terminated folded dipole. Dimensions for *A* and *B* are suggested in the text.

There are many questions unanswered: measured variation in standing-wave ratio over a given frequency range, loss in power attributable to the resistance termination, experimentally-obtained radiation patterns, etc.

Essentially, the system — shown in Fig. 1 — is a nonresonant folded dipole. It is fed with a 600-ohm line. This antenna, if horizontal, will be quite directional at right angles to its axis, with pronounced minima off the ends. As the antenna is tilted with respect to ground, this pattern gradually changes until at an angle of 30 degrees it becomes nondirectional for all practical purposes. Translated into terms of amateur construction this means that only one mast is required, together with a short pole six feet or so in height supporting the low end. There seems to be no marked advantage in an increase in over-all height of the antenna. On the contrary, reports from a distance indicate that signals are definitely better with one end of the antenna only six feet from the ground, perhaps because of a resulting lower angle of radiation.

Because complications are introduced by the resistance termination, it is difficult to make an adequate analysis or evaluation of a terminated folded dipole by conventional methods. It becomes necessary to measure performance experimentally.

One of the Navy laboratories has investigated the performance of this type of antenna and has reported unfavorably upon it. However, the laboratory study was based upon a vertical monopole erected over a metallic ground plane, using conventional measuring instruments, and the characteristics obtained were applied mathematically to arrive at theoretical characteristics for the resistance-terminated folded dipole. Operational tests were not made by this laboratory and their theoretical findings are not borne out by the limited practical tests conducted by the author.

It is of interest to note that the standing-wave ratios estimated by the laboratory for various frequencies from 4 to 22 Mc. ranged from a minimum of 1.4 to a maximum of 2.6, with an average close to 1.7. These ratios compare favorably with average s.w.r.s found in amateur installations. It should be remembered that these standing-wave ratios were not measured but were arrived at by calculation.

Dimensions

Fig. 1 gives a general idea of the system with the important dimensions indicated except for

*Comdr., USN; Electronics Officer, Boston Naval Shipyard, Boston, Mass.

the angle of tilt. Fig. 2 indicates the required tilt with a suggested pole arrangement and dimensions pertaining thereto. Two particular sizes should be of interest to amateurs, one of which will have maximum efficiency from 3.5 Mc. to

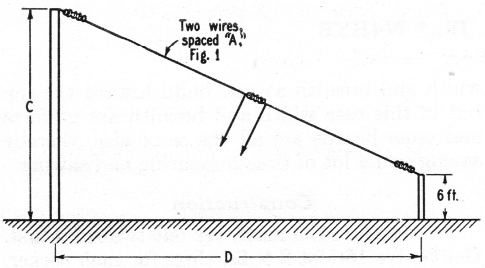


Fig. 2 — **Tilting the terminated folded dipole tends to make the pattern nondirectional. For dimensions *C* and *D*, see text.**

17.5 Mc. and the other being optimum from 7 Mc. to 35 Mc. Dimensions may be developed using the formulas set forth to cover higher-frequency bands, but at 28 Mc. and higher frequencies directional arrays are easy to construct and preferable because of the increased gain. The following dimensions are applicable to the frequency ranges selected above:

Dimension (*Figs. 1 and 2*)	*3.5 to 17.5 Mc.*	*7 to 35 Mc.*
A	2 ft. 10 in.	1 ft. 6 in.
B	46 ft. 10 in.	23 ft. 5 in.
C	56 ft. 0 in.	32 ft. 0 in.
D	80 ft. 0 in.	44 ft. 0 in.

For an impedance of 600 ohms, the center-to-center spacing of the feeder wires, divided by the diameter of the feeder wires, must equal 70. This means that No. 12 wire spaced six inches will be acceptable. Six-inch spreaders are readily available and the wire will not stretch unduly. No. 10 wire should be spaced 7 inches and No. 16 wire should be spaced 3½ inches.

Terminating Resistor

The terminating resistor should be non-inductive and have a minimum rating equal to 35 per cent of the input power to the final stage. It may be a carbon or graphite rod, adequately protected from the elements, or merely a long 600-ohm transmission line constructed of resistance wire. If the latter is used, the line may be carried vertically down from the center of one leg of the antenna to a short pole and then, if required, extended to one of the masts and doubled back and forth between the masts. If a carbon resistor is used, there is apparently no difference whether the rod is connected directly into the antenna as shown in Fig. 3, or at the end of a transmission line, as shown in Fig. 1. However, it is easier to adjust the resistance and protect it from the elements when it is installed at a fixed location on the ground than when it is suspended across an insulator in the antenna wire.

Formulas

The following formulas will be of assistance in developing antennas for different frequency coverages:

$$\textit{Antenna-wire spacing } (A) \textit{ for lowest frequency} = \frac{3000}{f\text{ (kc.)}} \times 3.28$$

$$\textit{Antenna length, each half } (B) \textit{ for lowest frequency} = \frac{50{,}000}{f\text{ (kc.)}} \times 3.28$$

To convert decimal parts of one foot into inches, multiply by 12.

One meter = 3.28 feet.

$$\textit{Frequency (kc.)} = \frac{300{,}000}{\lambda\text{ (meters)}}$$

The length of the antenna and the wire spacing may well be the object of further experiments but initial tests indicate that the first two formulas shown above are reasonably accurate and that the system is operable over a 5-to-1 frequency range as previously mentioned.

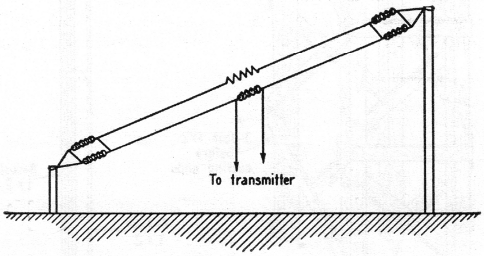


Fig. 3 — **The terminating resistor may be placed directly in the antenna, or at the end of a transmission line as indicated in Fig. 1.**

Initial tests with these antennas indicate no change in signal strength on 40 meters at a distance of 2000 miles when compared with a conventional half-wave antenna, center fed with tuned feeders and carefully adjusted for optimum output at one selected frequency. Good reports were received on both 20 and 80 meters but comparative reports are not available because of the lack of antennas specifically designed for those bands. Transmitter loading was normal.

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A Two-Bit Tower with Million-Dollar Performance

BY W. C. RIPPY, JR.,* W4HYR

ANTENNA trouble, mate? Then lend an ear to a plan for a sky hook that's simple and cheap to build, yet strong enough to withstand sleet, windstorms and other inclemencies of the weather. The idea was borrowed from steel towers used in constructing the Allatoona Dam in North Georgia. Those 100-foot towers were unusually strong, capable of supporting 40-ton buckets of concrete between them.

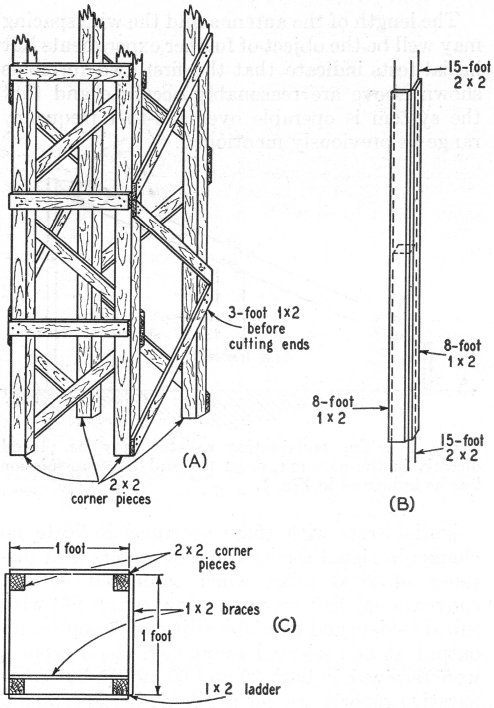


Fig. 1 — Details of the tower construction. The general assembly is shown at A, with a cross-sectional view at C. The method of joining the 2 × 2 corner posts is shown in B.

The antenna mast is a small replica of the construction tower. It looks like a 40-foot-high vine trellis, one foot square in cross section, with fourteen 3-foot 1 × 2s nailed zigzag fashion from bottom to top on four sides. The whole structure weighs only 180 pounds.

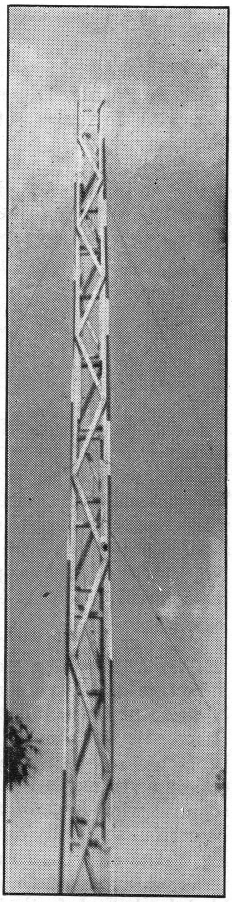
The unusual feature of this tower is the simplicity of construction. Some towers decrease in width and breadth as you build toward the top but in this case width and breadth are uniform and cross boards are all the same size, thereby saving you a lot of time measuring and sawing.

Construction

To construct the mast, lay out two sides first. Get twelve 15-foot 2 × 2s, three for each corner. Splice each three of them with 8-foot 1 × 2s, and you have four 45-foot pieces. Nail the fourteen 3-foot 1 × 2s zigzag fashion between each pair of the 45-foot lengths. The distance between each pair of long pieces is now one foot. Then nail 1-foot braces across the sides at the bottom, middle and top, three on each side.

The two sides are now ready to be put together — with more of the 3-foot 1 × 2s and short braces. When finished, you will have fourteen zigzag 1 × 2s and three braces from top to bottom on each side.

The ladder comes next, and then the paint. Future builders of such towers can profit by the writer's experience in two respects. First, put the ladder on the outside rather than on the inside of the structure! While having it on the inside may add to the beauty of the finished product, the pressure of climbing feet slowly presses the steps away from the corner pieces and in time weakens the nails to the danger point. Use conveniently-spaced short 1 × 2s for the ladder.



The "two-bit tower" belies its name, both in appearance and performance.

* 3542 Kingsboro Road, N.E., Atlanta, Ga.

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(We will supply stress diagrams for your building inspector)



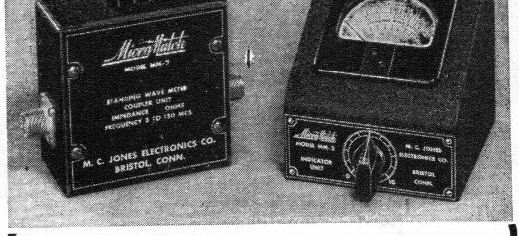
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excellent coöperation between neighboring stations has reduced to a minimum the amount of interference experienced. A number of stations have had their licenses modified from the 25-watt c.w.-only permit to 150-watt 'phone/c.w. permits. The Hong Kong society lost a keen supporter when VS6AS, and his wife, were killed in the Macao air-piracy disaster.

BELGIUM

The *Union Belge des Amateurs-Emetteurs* is now issuing the certificate WABP (Worked All Belgian Provinces). The requirement is that the applicant submit written proof of having contacted each of the nine provinces on each of two bands. (The *Call Book* at present lists the province after each call.) Applications for this award should be addressed to the U.B.A., Box 634, Brusselles.

CZECHOSLOVAKIA

The following v.h.f. and u.h.f. bands are currently available for use by amateurs in Czechoslovakia: 50–54 Mc., 144–150 Mc., 220–225 Mc., 420–460 Mc., 1215–1300 Mc., 2300–2450 Mc., 3300–3500 Mc., 5650–5850 Mc., 10,000–10,500 Mc., and 21,000–22,000 Mc. Class A operators are allowed 100 watts input, Class B operators 50 watts, and Class C operators 10 watts.

HRO

(Continued from page 53)

Antenna Shorting Relay

An additional refinement of particular interest to those who use relatively high-power transmitters is the use of a small, low-current relay for protecting the receiver by disconnecting and shorting the antenna coil during transmissions. A Potter-Brumfield d.p.d.t. relay, Type LM-11, with 10,000-ohm coil, is mounted under

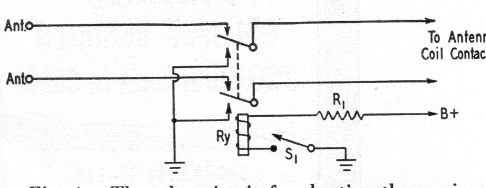


Fig. 4 — The relay circuit for shorting the receiver input during "transmit" periods.
R_1 — Adjusted to give operating voltage across relay *Ry*. Its value will depend upon the power-supply voltage available.
Ry — D.p.d.t. relay, 10,000-ohm coil (Potter-Brumfield LM-11, 10,000 ohms).
S_1 — S.p.s.t. toggle switch.

the chassis directly below the antenna input terminals and connected as shown in Fig. 4. The relay opens the antenna leads and shorts and grounds the antenna coil of the receiver. If desired, the relay can be wired so that removing the plate voltage from the receiver during transmission periods automatically switches the relay to the protective condition. But with the relay wired as shown, and controlled by S_1, the receiver can

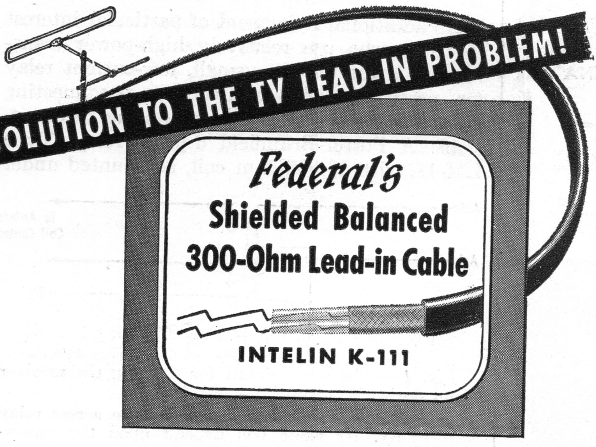
(Continued on page 118)

Hams in Essex County, New Jersey, PREFER ASTATIC MICROPHONES TWO TO ONE



● In Essex County, N. J., as around the world, Astatic Microphones remain the top preference of amateurs. A recently completed survey of that locality—neither instigated nor conducted by Astatic—provides interesting evidence of Astatic Mike popularity. Among 352 Hams, 101 own and operate Astatic Microphones. The figures are still more significant due to the fact that 85 of the 352 include owners of War Surplus units and miscellaneous types. The remaining 166 divide their choice of mikes among six other better known makes. No other make has half the representation in Essex County as that enjoyed by Astatic units. No test of product quality is more conclusive than that of actual use. The continued preference of amateurs for Astatic Mikes is their greatest endorsement.

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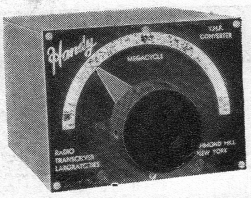
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be used for monitoring. The opening of the antenna leads and shorting and grounding the coil is far more effective than shorting the antenna leads, especially for 28-Mc. operation.

[If the receiver send-receive switch is rewired to leave voltage on the h.f. oscillator and the b.f.o., it will keep the power to these oscillators at a constant value and reduce any tendency to drift when the receiver is switched off during "transmit" periods. — *Ed.*]

Correspondence

(*Continued from page 62*)

314 W. Lakewood, Peoria 5, Ill.

Editor, *QST:*

The critics of ARRL's dues increase are living in the past — with the ten-cent loaf of bread. Things cost more today because people earn more. It's ridiculous to expect ARRL or any other organization to render a service at a prewar price. Why should some hams be so dumb about economics? I respect the fellow who says that Junior's shoes come first, but the guy who says the price is too high must be kidding.

And as for the ARRL services, we need them all — unimpaired. Even those of us who disagree with ARRL on minor issues will agree on the need for a strong organization to represent the amateur fraternity. I would certainly hate to see a forty-dollar-a-week man representing the amateurs at, for instance, a frequency-allocation conference where the big corporations send their $10,000-per-year men.

— *Cyrus Rohrer, jr., W9EKL*

Wilmington, Ohio

Editor, *QST:*

YOUR ARTICLE ON MEMBERSHIP DUES WAS VERY INTERESTING STOP SOME DOGS BITE THE HAND THAT FEEDS THEM BECAUSE THEY DO NOT KNOW ANY BETTER STOP MORE POWER TO YOU COMMA IF NECESSARY INCREASE THE DUES TO KEEP OUR AMATEUR ORGANIZATION STRONG.

— *H. M. Robison, W8HOX*

[Many thanks also to W1HWR, W1POL, W2CED, W2ZSK, W3OZF, W4MKB, W4MVM, W5NEQ, W8GSJ, W9RZS, KP4GV, VE6HM, VE6LQ, Harold McKay, Mike Schmitz, James Swanson, Robert Del Ciello and others for their comments on the April editorial. — *Ed.*]

PAGING MR. RAPP . . . WHO GETS AROUND

Estes Park, Colo.

Editor, *QST:*

Reference is made to "A New Approach to Antenna Design," by Larson E. Rapp, April, 1949, *QST*.

I think that a little explanation regarding his findings on standing-wave ratio should be made. The "indefinite impedance" to which he refers actually approaches zero as the antenna is tuned through permeability. This can easily be proven mathematically, thus substantiating his acquired results.

$$\text{Since} \int_{AD}^{BC} \frac{Apr}{1949} \times \frac{1}{73} = \gtrless 0 \text{ for 73 ohms}$$

$$\text{and} \int_{AD}^{BC} \frac{Apr}{1949} \times \frac{1}{300} = \gtrless 0 \quad \text{for 300 ohms,}$$

where *Apr* is the prospective rate to the antenna, it is readily seen that the mere substitution of a 300-ohm line for a 73-ohm coaxial cable would not affect the standing-wave ratio.

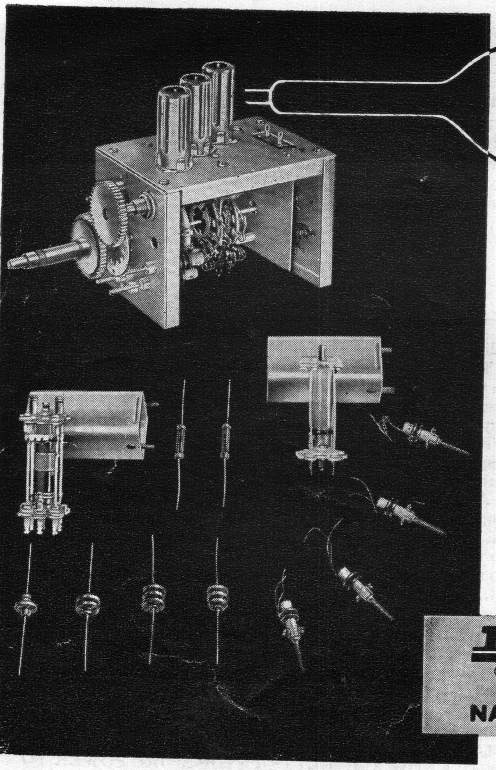
— *F. K. Matejka, WØDD*

Floundering-on-the-Hudson, N. Y.

Editor, *QST:*

I must call to the attention of Mr. Rapp some oversights which nullify his constructive efforts. In the first place,

(*Continued on page 120*)



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